Alternate Energy Systems, Inc.

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GraviBlend™-3 Gravitometer

PLC Controls

User Manual

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Revision Log:

Revision 2.0	12/03/00	Renamed Product to GraviBlend™-3 Added Function to suppress any alarm for S.G., C.V. or Wobbe, if their corresponding setpoints are set to 0 (zero). Added Function to suppress display of C.V. unless at least one setpoint (LowWarning, LowCutOff, HighWarning, HighCutOff) is activated. Added Function to suppress display of Wobbe unless at least one setpoint (LowWarning, LowCutOff, HighWarning, HighCutOff) is activated.
Revision 1.0	11/21/00	Set Manual Revision to 1.0 Added Appendix F, Setpoint Worksheet Renamed Program File to “GraviBlend-3 112100 1”
Revision 0.2	09/08/00	Changed Function Display: I know the Propane % Changed Function Display: I know the LPG CV+SG Changed Function Display: Enter LPG Vapor C.V. Changed Function Display: Enter LPG Vapor S.G.
Revision 0.1	09/06/00	Added Function: Specify CV and SG of LPG Mixture
Revision 0.0	09/04/00	Initial version

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User Manual PLC Controls and Display Unit for GraviBlend™-3 Gravitometer

All Functions and System Parameters of this gravitometer are controlled by a Programmable Logic Controller (PLC). The PLC communicates with a Display Unit (DU), which also has several Control Buttons and Function Buttons for the control of gravitometer functions.

The following sections describe the function of the PLC and the DU from the viewpoint of the user through descriptions of the functions of each key.

1. Display Unit

The Display Unit has an LCD display with 2 lines x 20 characters, 5 Control Buttons (Menu, , , Clear/Abort, Enter) and 5 Function Buttons (Alarm Test, Suppress/Silence Alarm, Display SG, Display WI, Display CV).

After initial Power-ON, the DU shows “Alternate Energy GraviBlend®-3”, indicating that the DU is under the control of the PLC.

1.1 Control Buttons

1.1.1 MENU

Press MENU to enter the top level menu. This level has 9 layers:

- Monitor Alarm Status
- Set Alarm Reminder
- Set Alarm Delay
- Pick LPG Composition
- I know the Propane %
- I know the LPG CV+SG
- Set Alarms
- Contact Information
- SG Sensor Cal Data

1.1.2

These buttons are used to scroll through the menu options, and to change the numeric value of any user-adjustable settings (see below).

1.1.3 CLEAR/ABORT

Press this button to leave any menu function and return to the initial display.

1.1.4 ENTER

Press this key to accept your menu selection. After changing the value of the numeric value of any user-adjustable settings, pressing this key accepts your changes.

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1.2 Menu Levels

1.2.1 Monitor Alarm Status

This menu selection offers the following options:

`ALARM: Lo SG Warning` Monitors the status of the “Low Specific Gravity Warning” alarm.

If no alarm exists, the display shows:
Top Line: `ALARM: Lo SG Warning`
Bottom Line: `Status: OKAY  / /CL`

If an alarm exists, the display shows:
Top Line: `ALARM: Lo SG Warning`
Bottom Line: `Status: ALARM  / /CL`

NOTE: The bottom line displays for all monitored alarm functions are the same and will not be repeated in this section.

`ALARM: Lo SG CutOff` Monitors the status of the “Low Specific Gravity Cutoff” alarm.

`ALARM: Hi SG Warning` Monitors the status of the “High Specific Gravity Warning” alarm.

`ALARM: Hi SG CutOff` Monitors the status of the “High Specific Gravity Cutoff” alarm.

`ALARM: Lo WI Warning` Monitors the status of the “Low Wobbe Index Warning” alarm.

`ALARM: Lo WI CutOff` Monitors the status of the “Low Wobbe Index Cutoff” alarm.

`ALARM: Hi WI Warning` Monitors the status of the “High Wobbe Index Warning” alarm.

`ALARM: Hi WI CutOff` Monitors the status of the “High Wobbe Index Cutoff” alarm.

`ALARM: Lo CV Warning` Monitors the status of the “Low Calorific Value Warning” alarm.

`ALARM: Lo CV CutOff` Monitors the status of the “Low Calorific Value Cutoff” alarm.

`ALARM: Hi CV Warning` Monitors the status of the “High Calorific Value Warning” alarm.

`ALARM: Hi CV CutOff` Monitors the status of the “High Calorific Value Cutoff” alarm.

To select any of the above options, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press ENTER	to select "`Monitor Alarm Status`". The first option "`ALARM: Lo SG Warning`" is offered.
Press ENTER or Press or	to select this option, to scroll through the next option, and then
Press ENTER	to select the function you would like to monitor. The status of all displayed functions is updated continuously.
Press or or Press CLEAR/ABORT	to scroll through other monitored alarms, when you are done monitoring the selected function. The display returns to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.2.2 Set Alarm Reminder

All alarms can be suppressed by pressing the key labeled "*Silence / Suppress Alarm*". However, as a safety measure, the alarms can only be suppressed/silenced for a set period of time. After that time has elapsed, the alarms are automatically turned on again. With function "`Set Alarm Reminder`" the length of time, until the suppressing/silencing of the alarms is being overridden by the PLC, can be adjusted.

The same setting also returns the display unit back to its original state, displaying the initial message "`Alternate Energy GraviBlend®-3`", if it has been left in any of the menu functions.

To adjust the time delay, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press	to scroll to the next option. Message "`Set Alarm Reminder`" appears.
Press ENTER	Messages "`Set AL Rmndr  X Min.`" and "` / /ENTER or CLEAR`" appear.
Press or	to change the setting between 1 and 10 minutes. You can not set the time below 1 or higher than 10.

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Press ENTER	Messages "`Alarm Remndr  X Min.`" and "`Cont: MENU or CLEAR`" appear.
Press MENU	Message "`Monitor Alarm Status`" appears.
Press ENTER	to select this option,
or	
Press or	to select another function,
or	
Press CLEAR/ABORT	to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

NOTE: All user-adjustable numeric values (Alarm Delay, Alarm Setpoints, LPG Composition, SG Sensor Calibration Data) can be adjusted following the procedure outlined above. This adjustment procedure will not be repeated in the following sections.

1.2.3 Set Alarm Delay

The alarm outputs will only be activated, if an alarm has existed for an preset period of time. This time can be adjusted using the "Set Alarm Delay" function. To activate this function, use the following procedure:

To adjust the delay, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press twice	to scroll to the "Set Alarm Delay" option. Message "`Set Alarm Delay`" appears.
Press ENTER	Messages "`Set AL Delay  XX sec`" and "` / /ENTER or CLEAR`" appear.

Follow the adjustment procedure outlined in section 1.2.2.

1.2.4 Pick LPG Composition

Specific Gravity of the mixed gas is the only directly measured parameter. Wobbe Index and Calorific Value of the gas are calculated based on the SG and the composition of the LPG. The GraviBlend-3 allows you to select from 22 pre-defined LPG mixtures (see Appendix A for a list), or to define your own LPG composition (see section 1.2.5).

To select one of the pre-defined mixtures, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.

Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press repeatedly	until "`Pick LPG Composition`" appears.
Press ENTER	Messages "`Commrcl Propane HD-5`" and "`Enter/Arrow/Clear`" appear.
Press ENTER or Press or	to accept this choice, to select any of the other 21 pre-defined mixtures.
Press ENTER	Messages "`New Mix: Comrcl Propane HD-5`" (or the mixture of your choice) and "`Press CLEAR to cont.`" appear.
Press CLEAR/ABORT	to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.2.5 I know the Propane %

If none of the pre-defined mixtures are close enough to your LPG composition, you can define your own. To simplify the operation, the assumption hereby is that the LPG only contains Propane and Butane. The percentage of Propane in the mixture can be entered through the standard adjustment procedure. The percentage of Butane in the mixture is automatically calculated as (100% – Propane% = Butane%).

To define your own mixture, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press rep eatedly	until "`I know the Propane %`" appears.
Press ENTER	Messages "`Enter Propane % xx.x`" and "` / /ENTER or CLEAR`" appear.
Press ENTER or Press or	to accept this choice, to adjust the Propane percentage.
Press ENTER	Messages "`New Propane % xx.x`" and "`Cont: MENU or CLEAR`" appear.
Press MENU or CLEAR	to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.2.6 I know the LPG CV + SG (Calorific Value and Specific Gravity)

If you know the Calorific Value and the Specific Gravity of the vapor of your (LPG) Mixture, you may enter these values using this function. Although selecting one of the pre-set mixture compositions or entering the Propane/Butane percentage of the mixture usually results in sufficient accuracy, using the actual data (found through the use of a Calorimeter or provided by your feedstock supplier) will further improve the accuracy of the calculated Caloric Value and Wobbe Index of the mixed gas.

To enter the data, follow this procedure:

Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press repeatedly	until "`I know the LPG CV + SG`" appears.
Press ENTER	Messages "`Enter LPG Vapor C.V.`" and "`Enter/Arrow/Clear`" appear.
Press ENTER	to accept this choice, to enter the Calorific Value of your LPG vapor,
or	
Press or	to scroll to the messages "`Enter LPG Vapor S.G.`" and "`Enter/Arrow/Clear`" to enter the Specific Gravity of your LPG vapor, then
Press ENTER	If you selected to enter the data for CV, messages "`Set CV xxxx BTU/Ft3`" and "`/ /ENTER/ or CLEAR`" appear. If you selected to enter the data for SG, messages "`Set Vapor S.G. x.xxx`" and "`/ /ENTER/ or CLEAR`" appear.
Press or	to change the settings.
Press ENTER	Messages "`New CV xxxx BTU/Ft3`" and "`Cont: MENU or CLEAR`", or "`New Vapor S.G. x.xxx`" and "`Cont: MENU or CLEAR`" appear.
Press MENU or CLEAR	to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.2.7 Set Alarms

The system continuously monitors a total of 12 setpoints. They are:

Low Specific Gravity Warning
Low Specific Gravity Cutoff
High Specific Gravity Warning
High Specific Gravity Cutoff
Low Wobbe Index Warning
Low Wobbe Index Cutoff
High Wobbe Index Warning
High Wobbe Index Cutoff
Low Calorific Value Warning
Low Calorific Value Cutoff
High Calorific Value Warning
High Calorific Value Cutoff

The values for these alarm setpoints can be adjusted individually. Any “Warning” Alarm will turn on outputs Y0, “Visual Alarm, any Warning” and Y1, “Audible Alarm, any Warning”. Any “Cutoff” Alarm will also turn on output Y2, “Alarm, any Cutoff”.

To adjust any of the Alarm Setpoints, follow this procedure:

Press CLEAR/ABORT.	Message “`Alternate Energy GraviBlend®-3`” appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option “`Monitor Alarm Status`” appears.
Press repeatedly	until “`Set Alarms`” appears.
Press ENTER	Messages “`Set Lo SG Warning`” and “`Enter/Arrow/Clear`” appear.
Press ENTER or Press or	to accept this choice, to select one of the other 11 Alarm Setpoints.
Press ENTER	Messages “`Set LoSG Warn. x.xxx`” (or the setpoint of your choice) and “ `/ /ENTER or CLEAR`” appear.

Adjust setpoints using the standard adjustment procedure.

NOTE: Setting the value for any Alarm setpoint to 0 (zero) de-activates the alarm function for this particular monitoring point.

1.2.8 Contact Information

This function displays name, address, phone and fax number, e-mail address and web site address for Alternate Energy Systems.

To select this function, follow this procedure:

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Press CLEAR/ABORT.	Message "`Alternate Energy GraviBlend®-3`" appears. If this message is already displayed, you do not have to press this key.
Press MENU.	First Option "`Monitor Alarm Status`" appears.
Press repeatedly	until Message "`Contact Information`" appears.
Press ENTER	Message "`Alternate Energy`" appears in the top line of the DU, and message "`Enter/Arrow/Clear`" appears in the bottom line of the DU.
Press or repeatedly	to scroll to the messages. With each pressing of or the top line of the display changes.
Press CLEAR/ABORT	when you are done. The display returns to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.2.9 SG Sensor Cal Data

This function is only available to factory personnel during initial setup.

1.3 Function Buttons

The function Buttons are the 5 buttons in the bottom row of the DU. They are labeled "Alarm Test", "Suppress/Silence Alarm", "Display SG", "Display WI", "Display CV", respectively.

1.3.1 Alarm Test (Momentary Function)

Pressing this key tests all alarm outputs (Y1, Y2, Y3).

1.3.2 Suppress/Silence Alarm (Alternating Function)

Pressing this alternating key selects or de-selects the "Suppress/Silence Alarm" function. Any alarm conditions occurring while this function is selected will not activate any of the three Alarm Outputs.

As described above, the "Suppress/Silence Alarm" function will automatically be overridden by the PLC after a pre-set period of time has elapsed. When this occurs, outputs Y0 (Visual Alarm) and Y2 (Alarm, any Cutoff) will be re-activated. Output Y1 (Audible Alarm) remains de-activated.

While the "Suppress/Silence Alarm" function is selected, the red LED in the upper left hand corner of the button is illuminated.

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1.3.3 Display SG, Specific Gravity (Momentary Function)

Pressing this momentary key sets the display to "Display Specific Gravity" mode. In this mode, the top line displays "`Spec. Gravity  x.xxx`", and the bottom line displays "`Press CLEAR to cont.`".

From this mode, you can either press the button labeled "*Display WI*" to display the Wobbe Index, the button labeled "*Display CV*" to display the Calorific Value, or the CLEAR button to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

1.3.4 Display WI, Wobbe Index (Momentary Function)

Pressing this momentary key sets the display to "Display Wobbe Index" mode. In this mode, the top line displays "`Wobbe # xxxx BTU/Ft3`", and the bottom line displays "`Press CLEAR to cont.`".

From this mode, you can either press the button labeled "*Display SG*" to display the Specific Gravity, the button labeled "*Display CV*" to display the Calorific Value, or the CLEAR button to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

NOTE: This function is only available, if at least one alarm setpoint for the Wobbe Index is activated (greater than 0). If all alarm setpoints are set to 0 (zero), pressing this button will not change the display.

1.3.5 Display CV, Calorific Value (Momentary Function)

Pressing this momentary key sets the display to "Display Calorific Value" mode. In this mode, the top line displays "`Cal.Val. xxxx BT/Ft3`", and the bottom line displays "`Press CLEAR to cont.`".

From this mode, you can either press the button labeled "*Display SG*" to display the Specific Gravity, the button labeled "*Display WI*" to display the Wobbe Index, or the CLEAR button to return the display to the initial message "`Alternate Energy GraviBlend®-3`", indicating that it is ready.

NOTE: This function is only available, if at least one alarm setpoint for the Calorific Value is activated (greater than 0). If all alarm setpoints are set to 0 (zero), pressing this button will not change the display.

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2. PLC Inputs / Outputs

The PLC has 4 analog inputs (1 to 4), 8 DC inputs (X0 to X7) and 6 relay outputs (Y0 to Y5). Red LEDs above inputs X0 to X7 and outputs Y0 to Y5 indicate the status (ON = active, OFF = not active).

In standard systems (Gravitometer only), only Analog Input 4 and Outputs Y0, Y1 and Y2 are used.

Inputs X0 and X1 and outputs Y4 and Y5 are reserved for AccuBlend systems.

Y0	Visual Alarm	any Warning Alarm
Y1	Audible Alarm	any Warning Alarm
Y2	Cutoff Alarm	any Cutoff Alarm
Y3	available	
Y4	AccuBlend	turn CW
Y5	AccuBlend	turn CCW

3. Alarm Indicator Mode

When an alarm condition occurs, the DU is in its “idle” state (displaying the initial message “`Alternate Energy GraviBlend®-3`”), and the “Alarm Delay” has elapsed, the DU displays “`ALARM Status exists!`” and “`Sel. MENU + AL Stat.`”.

Follow the procedure outlined in section 1.2.1 to locate the reason for the Alarm. You could also use one of the function buttons to immediately monitor SG, WI, or CV.

After clearing the reason for the Alarm, press CLEAR to reset the Alarm Outputs.

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Appendix A List of Selectable LPG Mixtures

	Propane	Butane		
BTU/cuft	2516	3280		
S.G.	1.53	2.00		
Mixture	Propane %	Butane %	Calorific Value	Specific Gravity
1	Commercial Propane HD-5		2554	1.554
2	100%	0%	2516	1.530
3	95%	5%	2554	1.554
4	90%	10%	2592	1.577
5	85%	15%	2631	1.601
6	80%	20%	2669	1.624
7	75%	25%	2707	1.648
8	70%	30%	2745	1.671
9	65%	35%	2783	1.695
10	60%	40%	2822	1.718
11	55%	45%	2860	1.742
12	50%	50%	2898	1.765
13	45%	55%	2936	1.789
14	40%	60%	2974	1.812
15	35%	65%	3013	1.836
16	30%	70%	3051	1.859
17	25%	75%	3089	1.883
18	20%	80%	3127	1.906
19	15%	85%	3165	1.930
20	10%	90%	3204	1.953
21	5%	95%	3242	1.977
22	0%	100%	3280	2.000

Appendix B PLC Program Elements – Messages
Internal use only.

Appendix C PLC Program Elements – Menu Items
Internal use only.

Appendix D PLC Program Elements – Inputs/Outputs/Control Relays
Internal use only.

Appendix E PLC Program Elements – Memory Locations
Internal use only.

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Appendix F System Setpoints Factory Settings / User Settings Worksheet

The following worksheet lists all setpoints monitored by the PLC and their factory settings (for Propane/Air Mixtures).

Use the second column to record the settings for your specific application.

SETPOINT	Factory Setting	User Setting
LoSGCutOff	1.150	
LoSG Warn.	1.200	
Typical Value	1.320	
HiSG Warn.	1.400	
HiSGCutOff	1.450	
LoWI CutOff	650	
Lo WI Warn.	850	
Typical Value	1300	
Hi WI Warn.	1550	
HiWI CutOff	1750	
LoCV CutOff	750	
Lo CV Warn.	950	
Typical Value	1500	
Hi CV Warn.	1850	
HiCV CutOff	2050	

Appendix G Calculation of Mixed Gas Composition based on S.G. reading and Feedstock Properties

The following formula can be used to calculate the vapor/air composition of the mixed gas. The two tables below show the results of the calculation for two different feedstock properties (HD-5, 95% propane, 5% butane, and a typical butane propane mixture with 70% butane and 30% propane).

$$\text{Vapor Volume [\%]} = \frac{1 - SG_{\text{mixed gas}}}{1 - SG_{\text{raw vapor}}} \times 100$$

Prop %	But %	S.G.	C.V.	Wobbe
95%	5%	1.554	2554	2049

LPG %	Air %	S.G.	C.V.	Wobbe
27.10%	72.9%	1.15	692	645
28.91%	71.1%	1.16	738	686
30.71%	69.3%	1.17	784	725
32.52%	67.5%	1.18	831	765
34.33%	65.7%	1.19	877	804
36.13%	63.9%	1.20	923	843
37.94%	62.1%	1.21	969	881
39.75%	60.3%	1.22	1015	919
41.55%	58.4%	1.23	1061	957
43.36%	56.6%	1.24	1108	995
45.17%	54.8%	1.25	1154	1032
46.97%	53.0%	1.26	1200	1069
48.78%	51.2%	1.27	1246	1106
50.59%	49.4%	1.28	1292	1142
52.39%	47.6%	1.29	1338	1178
54.20%	45.8%	1.30	1384	1214
56.01%	44.0%	1.31	1431	1250
57.81%	42.2%	1.32	1477	1285
59.62%	40.4%	1.33	1523	1320
61.43%	38.6%	1.34	1569	1355
63.23%	36.8%	1.35	1615	1390
65.04%	35.0%	1.36	1661	1425
66.85%	33.2%	1.37	1707	1459
68.65%	31.3%	1.38	1754	1493
70.46%	29.5%	1.39	1800	1526
72.27%	27.7%	1.40	1846	1560
74.07%	25.9%	1.41	1892	1593
75.88%	24.1%	1.42	1938	1626
77.69%	22.3%	1.43	1984	1659
79.49%	20.5%	1.44	2030	1692
81.30%	18.7%	1.45	2077	1725
83.11%	16.9%	1.46	2123	1757
84.91%	15.1%	1.47	2169	1789
86.72%	13.3%	1.48	2215	1821
88.53%	11.5%	1.49	2261	1852
90.33%	9.7%	1.50	2307	1884

Prop %	But %	S.G.	C.V.	Wobbe
30%	70%	1.859	3051	2238

LPG %	Air %	S.G.	C.V.	Wobbe
34.92%	65.1%	1.30	1065	934
36.09%	63.9%	1.31	1101	962
37.25%	62.7%	1.32	1137	989
38.42%	61.6%	1.33	1172	1016
39.58%	60.4%	1.34	1208	1043
40.75%	59.3%	1.35	1243	1070
41.91%	58.1%	1.36	1279	1096
43.07%	56.9%	1.37	1314	1123
44.24%	55.8%	1.38	1350	1149
45.40%	54.6%	1.39	1385	1175
46.57%	53.4%	1.40	1421	1201
47.73%	52.3%	1.41	1456	1226
48.89%	51.1%	1.42	1492	1252
50.06%	49.9%	1.43	1527	1277
51.22%	48.8%	1.44	1563	1302
52.39%	47.6%	1.45	1598	1327
53.55%	46.4%	1.46	1634	1352
54.71%	45.3%	1.47	1669	1377
55.88%	44.1%	1.48	1705	1401
57.04%	43.0%	1.49	1740	1426
58.21%	41.8%	1.50	1776	1450
59.37%	40.6%	1.51	1811	1474
60.54%	39.5%	1.52	1847	1498
61.70%	38.3%	1.53	1882	1522
62.86%	37.1%	1.54	1918	1545
64.03%	36.0%	1.55	1953	1569
65.19%	34.8%	1.56	1989	1592
66.36%	33.6%	1.57	2024	1616
67.52%	32.5%	1.58	2060	1639
68.68%	31.3%	1.59	2095	1662
69.85%	30.2%	1.60	2131	1685
71.01%	29.0%	1.61	2166	1707
72.18%	27.8%	1.62	2202	1730
73.34%	26.7%	1.63	2237	1753
74.51%	25.5%	1.64	2273	1775
75.67%	24.3%	1.65	2309	1797

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